

The following section is from HDFEOS users guide that explains the generalization made to EASE grid and BCEA projection in the new version of HDFEOS.

6.5 GCTP Usage

The HDF-EOS Grid API uses the U.S. Geological Survey General Cartographic Transformation Package (GCTP) to define and subset grid structures. This section describes codes used by the package.

6.5.1 GCTP Projection Codes

The following GCTP projections are supported for HDFEOS. The projection codes are used in the grid API described in Section 6 below:

GCTP_GEO	(0)	Geographic
GCTP_UTM	(1)	Universal Transverse Mercator
GCTP_ALBERS	(3)	Albers Conical Equal_Area
GCTP_LAMCC	(4)	Lambert Conformal Conic
GCTP_MERCAT	(5)	Mercator
GCTP_PS	(6)	Polar Stereographic
GCTP_POLYC	(7)	Polyconic
GCTP_TM	(9)	Transverse Mercator
GCTP_LAMAZ	(11)	Lambert Azimuthal Equal Area
GCTP_HOM	(20)	Hotine Oblique Mercator
GCTP_SOM	(22)	Space Oblique Mercator
GCTP_GOOD	(24)	Interrupted Goode Homolosine
GCTP_ISINUS1	(31)	Integerized Sinusoidal Projection*
GCTP_ISINUS	(99)	Integerized Sinusoidal Projection*
GCTP_BCEA	(98)	Behrmann Cylindrical Equal-Area (for EASE grid)**

* The Integerized Sinusoidal Projection was not part of the original GCTP package. It has been added by ECS. See *Level-3 SeaWiFS Data Products: Spatial and Temporal Binning Algorithms*. Additional references are provided in Section 2.

** The Behrmann Cylindrical Equal-Area Projection was not part of the original GCTP package. It has been added by ECS. See Notes for section 6.5.4.

In the new GCTP package the Integerized Sinusoidal Projection is included as the 31st projection. The Code 31 was added to HDFEOS for users who wish to use 31 instead of 99 for Integerized Sinusoidal Projection.

Note that other projections supported by GCTP will be adapted for HDF-EOS Version 2.8 as new user requirements are surfaced. For further details on the GCTP projection package, please refer to Section 6.3.4 and Appendix G of the SDP Toolkit Users Guide for the ECS Project, March, 2002, (333-CD-605-001).

6.5.2 UTM Zone Codes

The Universal Transverse Mercator (UTM) Coordinate System uses zone codes instead of specific projection parameters. The table that follows lists UTM zone codes as used by GCTP Projection Transformation Package. C.M. is Central Meridian

Zone	C.M.	Range	Zone	C.M.	Range
01	177W	180W-174W	31	003E	000E-006E
02	171W	174W-168W	32	009E	006E-012E
03	165W	168W-162W	33	015E	012E-018E
04	159W	162W-156W	34	021E	018E-024E
05	153W	156W-150W	35	027E	024E-030E
06	147W	150W-144W	36	033E	030E-036E
07	141W	144W-138W	37	039E	036E-042E
08	135W	138W-132W	38	045E	042E-048E
09	129W	132W-126W	39	051E	048E-054E
10	123W	126W-120W	40	057E	054E-060E
11	117W	120W-114W	41	063E	060E-066E
12	111W	114W-108W	42	069E	066E-072E
13	105W	108W-102W	43	075E	072E-078E
14	099W	102W-096W	44	081E	078E-084E
15	093W	096W-090W	45	087E	084E-090E
16	087W	090W-084W	46	093E	090E-096E
17	081W	084W-078W	47	099E	096E-102E
18	075W	078W-072W	48	105E	102E-108E
19	069W	072W-066W	49	111E	108E-114E
20	063W	066W-060W	50	117E	114E-120E
21	057W	060W-054W	51	123E	120E-126E
22	051W	054W-048W	52	129E	126E-132E
23	045W	048W-042W	53	135E	132E-138E
24	039W	042W-036W	54	141E	138E-144E
25	033W	036W-030W	55	147E	144E-150E
26	027W	030W-024W	56	153E	150E-156E
27	021W	024W-018W	57	159E	156E-162E
28	015W	018W-012W	58	165E	162E-168E
29	009W	012W-006W	59	171E	168E-174E
30	003W	006W-000E	60	177E	174E-180W

6.5.3 GCTP Spheroid Codes

Clarke 1866 (default)	(0)
Clarke 1880	(1)
Bessel	(2)
International 1967	(3)
International 1909	(4)
WGS 72	(5)
Everest	(6)
WGS 66	(7)
GRS 1980	(8)
Airy	(9)
Modified Airy	(10)
Modified Everest	(11)
WGS 84	(12)
Southeast Asia	(13)
Australalian National	(14)

Krassovsky	(15)
Hough	(16)
Mercury 1960	(17)
Modified Mercury 1968	(18)
Sphereof Radius 6370997m	(19)

6.5.4 Projection Parameters

Table 6-2. Projection Transformation Package Projection Parameters (1 of 2)

	Array Element							
Code & Projection Id	1	2	3	4	5	6	7	8
0 Geographic								
1 U T M	Lon/Z	Lat/Z						
3 Albers Conical Equal_Area	Smajor	Sminor	STDPR1	STDPR2	CentMer	OriginLat	Fe	Fn
4 Lambert Conformal C	Smajor	Sminor	STDPR1	STDPR2	CentMer	OriginLat	FE	FN
5 Mercator	Smajor	Sminor			CentMer	TrueScale	FE	FN
6 Polar Stereographic	Smajor	Sminor			LongPol	TrueScale	FE	FN
7 Polyconic	Smajor	Sminor			CentMer	OriginLat	FE	FN
9 Transverse Mercator	Smajor	Sminor	Factor		CentMer	OriginLat	FE	FN
11 Lambert Azimuthal	Sphere				CentLon	CenterLat	FE	FN
20 Hotin Oblique Merc A	Smajor	Sminor	Factor			OriginLat	FE	FN
20 Hotin Oblique Merc B	Smajor	Sminor	Factor	AziAng	AzmthPt	OriginLat	FE	FN
22 Space Oblique Merc A	Smajor	Sminor		IncAng	AscLong		FE	FN

Table 6-2. Projection Transformation Package Projection Parameters (2 of 2)

	Array Element							
22 Space Oblique Merc B	Smajor	Sminor	Satnum	Path			FE	FN
24 Interrupted Goode	Sphere							
31 & 99 Integerized Sinusoidal	Sphere				CentMer		FE	FN
98 BCEA utilized by EASE grid (see Notes)	Smajor	Sminor			CentMer	TrueScale	FE	FN

Table 6-3. Projection Transformation Package Projection Parameters Elements

Code & Projection Id	Array Element				
	9	10	11	12	13
0 Geographic					
1 U T M					
3 Albers Conical Equal_Area					
4 Lambert Conformal C					
5 Mercator					
6 Polar Stereographic					
7 Polyconic					
9 Transverse Mercator					
11 Lambert Azimuthal					
20 Hotin Oblique Merc A	Long1	Lat1	Long2	Lat2	zero
20 Hotin Oblique Merc B					one
22 Space Oblique Merc A	PSRev	SRat	PFlag	HDF-EOS Para	zero
22 Space Oblique Merc B				HDF-EOS Para	one
24 Interrupted Goode					
31 & 99 Integerized Sinusoidal	NZone		RFlag		
98 BCEA utilized by EASE grid (see Notes)					

Where,

- Lon/Z Longitude of any point in the UTM zone or zero. If zero, a zone code must be specified.
- Lat/Z Latitude of any point in the UTM zone or zero. If zero, a zone code must be specified.
- Smajor Semi-major axis of ellipsoid. If zero, Clarke 1866 in meters is assumed.
- Sminor Eccentricity squared of the ellipsoid if less than zero, if zero, a spherical form is assumed, or if greater than zero, the semi-minor axis of ellipsoid.
- Sphere Radius of reference sphere. If zero, 6370997 meters is used.
- STDPR1 Latitude of the first standard parallel
- STDPR2 Latitude of the second standard parallel
- CentMer Longitude of the central meridian
- OriginLat Latitude of the projection origin
- FE False easting in the same units as the semi-major axis
- FN False northing in the same units as the semi-major axis
- TrueScale Latitude of true scale
- LongPol Longitude down below pole of map
- Factor Scale factor at central meridian (Transverse Mercator) or center of projection (Hotine Oblique Mercator)

CentLon	Longitude of center of projection
CenterLat	Latitude of center of projection
Long1	Longitude of first point on center line (Hotine Oblique Mercator, format A)
Long2	Longitude of second point on center line (Hotine Oblique Mercator, frmt A)
Lat1	Latitude of first point on center line (Hotine Oblique Mercator, format A)
Lat2	Latitude of second point on center line (Hotine Oblique Mercator, format A)
AziAng	Azimuth angle east of north of center line (Hotine Oblique Mercator, frmt B)
AzmthPt	Longitude of point on central meridian where azimuth occurs (Hotine Oblique Mercator, format B)
IncAng	Inclination of orbit at ascending node, counter-clockwise from equator (SOM, format A)
AscLong	Longitude of ascending orbit at equator (SOM, format A)
PSRev	Period of satellite revolution in minutes (SOM, format A)
SRat	Satellite ratio to specify the start and end point of x,y values on earth surface (SOM, format A -- for Landsat use 0.5201613)
PFlag	End of path flag for Landsat: 0 = start of path, 1 = end of path (SOM, frmt A)
Satnum	Landsat Satellite Number (SOM, format B)
Path	Landsat Path Number (Use WRS-1 for Landsat 1, 2 and 3 and WRS-2 for Landsat 4 and 5.) (SOM, format B)
Nzone	Number of equally spaced latitudinal zones (rows); must be two or larger and even
Rflag	Right justify columns flag is used to indicate what to do in zones with an odd number of columns. If it has a value of 0 or 1, it indicates the extra column is on the right (zero) left (one) of the projection Y-axis. If the flag is set to 2 (two), the number of columns are calculated so there are always an even number of columns in each zone.

Notes:

- Array elements 14 and 15 are set to zero.
- All array elements with blank fields are set to zero.

All angles (latitudes, longitudes, azimuths, etc.) are entered in packed degrees/ minutes/ seconds (DDDMMMSSS.SS) format.

The following notes apply to the Space Oblique Mercator A projection:

- A portion of Landsat rows 1 and 2 may also be seen as parts of rows 246 or 247. To place these locations at rows 246 or 247, set the end of path flag (parameter 11) to 1--end of path. This flag defaults to zero.
- When Landsat-1,2,3 orbits are being used, use the following values for the specified parameters:
 - Parameter 4 099005031.2
 - Parameter 5 128.87 degrees - (360/251 * path number) in packed DMS format
 - Parameter 9 103.2669323
 - Parameter 10 0.5201613

- When Landsat-4,5 orbits are being used, use the following values for the specified parameters:
 - Parameter 4 098012000.0
 - Parameter 5 129.30 degrees - (360/233 * path number) in packed DMS format
 - Parameter 9 98.884119
 - Parameter 10 0.5201613

The following notes apply for EASE grid:

The following notes apply for **BCEA projection and EASE grid**:

HDFEOS 2.7 and 2.8:

Behrmann Cylindrical Equal-Area (BCEA) projection was used for 25 km global EASE grid. For this projection the Earth radius is set to 6371228.0m and latitude of true scale is 30 degrees. For 25 km global EASE grid the following apply:

```

Grid Dimensions:
  Width 1383
  Height 586
Map Origin:
  Column (r0) 691.0
  Row (S0) 292.5
  Latitude 0.0
  Longitude 0.0
Grid Extent:
  Minimum Latitude 86.72S
  Maximum Latitude 86.72N
  Minimum Longitude 180.00W
  Maximum Longitude 180.00E
  Actual grid cell size 25.067525km

```

Grid coordinates (r,s) start in the upper left corner at cell (0,0), with r increasing to the right and s increasing downward.

This Update to HDFEOS 2.8 :

Although the projection code and name kept the same, BCEA projection was generalized to accept Latitude of True Scales other than 30 degrees, Central Meridian other than zero, and ellipsoid earth model besides the spherical one with user supplied radius. This generalization along with the removal of hard coded grid parameters will allow users not only subsetting, but also creating other grids besides the 25 km global EASE grid and having freedom to use different appropriate projection parameters. With the current version one can create the above mentioned 25 km global EASE grid of previous versions using:

```

Grid Dimensions:
  Width 1383
  Height 586
Grid Extent:

```

```
UpLeft Latitude 86.72
LowRight Latitude -86.72
UpLeft Longitude -180.00
LowRight Longitude 180.00
Projection Parameters:
1) 6371.2280/25.067525 = 254.16263
2) 6371.2280/25.067525 = 254.16263
5) 0.0
6) 30000000.0
7) 691.0
8) -292.5
```

Also one may create **12.5 km global EASE grid** using:

```
Grid Dimensions:
Width 2766
Height 1171
Grid Extent:
UpLeft Latitude 85.95
LowRight Latitude -85.95
UpLeft Longitude -179.93
LowRight Longitude 180.07
Projection Parameters:
1) 6371.2280/(25.067525/2) = 508.325253
2) 6371.2280/(25.067525/2) = 508.325253
5) 0.0
6) 30000000.0
7) 1382.0
8) -585.0
```

Any other grids (normalized pixel or not) with generalized BCEA projection can be created using appropriate grid corners, dimension sizes, and projection parameters. Please note that like other projections Semi-major and Semi-minor axes will default to Clarke 1866 values (in meters) if they are set to zero.